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Embryology of *Tephrosia villosa* (L.) Pers. (Fabaceae)

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Tephrosia villosa (L.) Pers. (マメ科) の胚学的研究

Tephrosia, a large genus comprising 300 species, belongs to the tribe Galegeae of the subfamily Faboideae of the family Fabaceae. Rau (1953) and Johri & Garg (1959) studied the endosperm development in *Tephrosia purpurea* and *T. villosa* respectively. Seshavatharam (1982b) studied complete embryology of *Tephrosia maxima*, *T. purpurea*, *T. pumila* and *T. strigosa*. As *Tephrosia villosa* has not been studied, except for endosperm development, the present investigation has been undertaken.

Material and methods Buds, flowers and fruits at various stages of development were collected from the plants growing in the Sri Krishnadevaraya University campus and fixed in formalin-acetic acid-alcohol (F. A. A.). Usual methods of dehydration, infiltration and embedding were followed. The sections cut at 8–9 μm thickness were stained in Delafield's haematoxylin. The material posed lot of difficulties due to the presence of hairs on floral parts. Endosperm development has also been studied by hand dissections.

Observations Microsporangium, microsporogenesis and male gametophyte. The anther is tetrasporangiate (Fig. 1 A). Four large glandular cells, one in each lobe, are seen in transverse section (Fig. 1 A). The archesporium, which is single-layered, cuts off primary parietal layer towards out side and primary sporogenous layer towards inside. The primary parietal layer undergoes periclinal division forming two layers (Fig. 1 B). The inner layer functions as tapetum while the outer layer divides once again forming endothecium towards outside and a middle layer (Fig. 1 C, D). This type of anther wall development according to Davis (1966) is of the Dicotyledonous type. Epidermis persists in the mature anther as flattened cells (Fig. 1 E). Endothecium develops fibrous thickenings forming fibrous endothecium (Fig. 1 E). Middle layer gets crushed and degenerated during meiosis. Anther tapetum is of the Glandular type (Fig.

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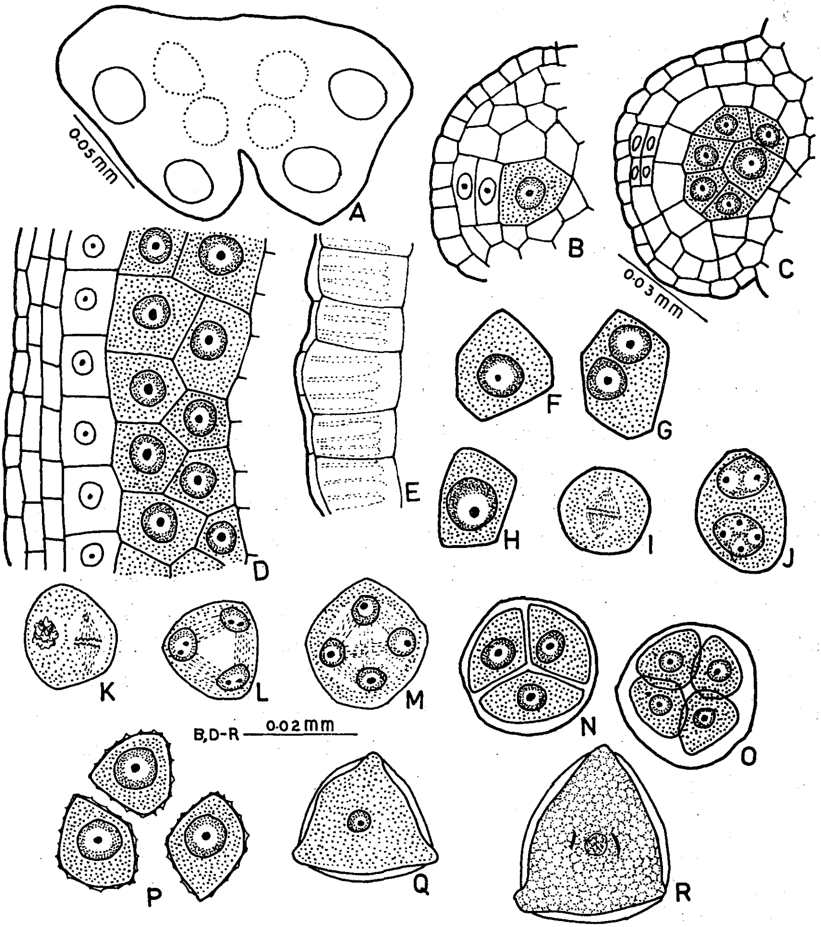

Fig. 1. *Tephrosia villosa.* A. Tetrasporangiate anther. B, C. Transverse section of anther lobes showing wall layers and sporogenous cells. D. Longitudinal section of part of anther lobe showing wall layers and pollen mother cells. E. Epidermis and fibrous endothecium. F. G. Anther tapetal cells. H-M. Pollen mother cells in meiosis. N. Tetrahedral pollen tetrad. O. Decussate pollen tetrad. P. Pollen grains released from the tetrad. Q. Uninucleate pollen grain. R. 3-celled pollen grain.

1 D). Its cells are uninucleate (Fig. 1 F), but rarely 2-nucleate tapetal cells are met with (Fig. 1 G).

The primary sporogenous cells undergo anti- and periclinal divisions forming a moderate mass of pollen mother cells (Fig. 1 C, D). The pollen mother cells undergo meiotic division (Fig. 1 H–M). Cytokinesis is simultaneous. Pollen tetrads are tetrahedral and decussate (Fig. 1 N–P). The microspores after separation develop exine (Fig. 1 P, Q). Pollen grains at the time of shedding are 3-celled with three germ pores and thick smooth exine (Fig. 1 R).

Ovary, ovule, megasporogenesis and female gametophyte. The ovary is monocarpellary, unilocular with 5–6 ovules on marginal placentation. The ovule is anatropous, bitegmic and crassinucellate (Fig. 2 A, E). It arises as a papillate outgrowth from the placentum. The outer integument encloses the inner integument. Micropyle is formed by both the integuments and the path is zig-zag (Fig. 2E). The female archesporium is hypodermal and single-celled. It cuts off a parietal cell towards out side and a megaspore mother cell towards inside. The parietal cell undergoes periclinal and anticlinal divisions resulting in two-layered parietal tissue (Fig. 2 A). The megaspore mother cell undergoes meiosis resulting in a linear tetrad of megaspores (Fig. 2 B). The chalazal megaspore is functional while the micropylar three megaspores degenerate (Fig. 2 C). The functional megaspore elongates and undergoes 3 nuclear divisions resulting in an 8-nucleate, 7-celled embryo sac of the Polygonum type (Fig. 2 C, D, F). The embryo sac is oval in shape. The synergids are hooked (Fig. 2 F). They degenerate soon after fertilisation. The antipodals cells are three in number and they are uninucleate. The antipodals are ephemeral.

Fertilisation and endosperm. Fertilisation is porogamous. Syngamy and triple fusion proceed more or less simultaneously.

Endosperm development is of the Nuclear type. The primary endosperm nucleus divides earlier than the zygote forming two free nuclei (Fig. 2 G, H). These two nuclei undergo repeated nuclear divisions resulting in large number of free nuclei which are distributed in the periphery. At about the globular stage of the embryo the micropylar part of the endosperm becomes cellular. Wall formation starts from the periphery and proceeds to the centre. The chalazal half of the endosperm remains coenocytic and functions as haustorium (Fig. 2 I). The tip of the endosperm haustorium ends in a club-shaped structure (Fig. 2 I). All the cells of the cellular part of the endosperm are uninucleate.

Discussion Development of anther and male gametophyte in *Tephrosia villosa* are in conformity with those members of the Faboideae investigated earlier (Seshavatharam 1982a, b, c, Swarajyalakshmi et al. 1987).

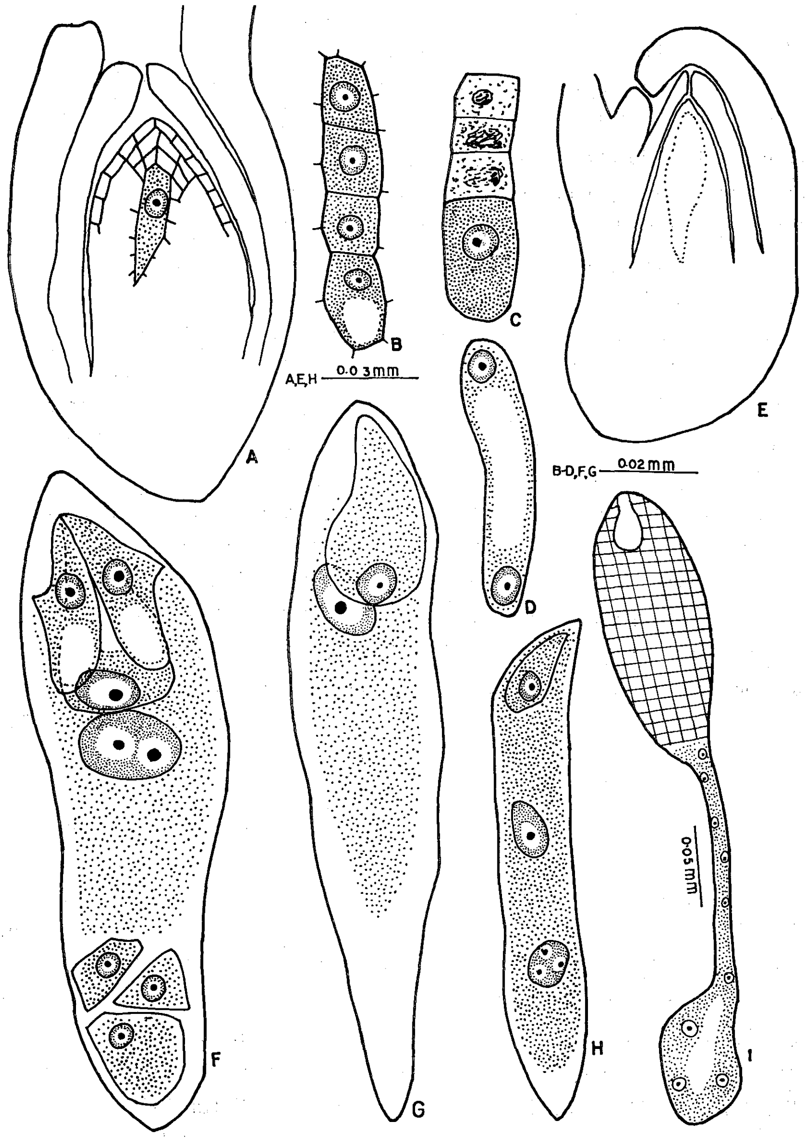

Fig. 2. *Tephrosia villosa.* A. Ovule showing megaspore mother cell. B, C. Megaspore tetrads. D. 2-nucleate embryo sac. E. Ovule showing embryo sac. F. Organised embryo sac. G. Embryo sac showing zygote and primary endosperm nucleus. H, I. Stages in the development of endosperm.

The ovule in *Tephrosia villosa* (present study) is anatropous, bitegumic and crassinucellate. Anatropous ovules have also been reported in *Tephrosia purpurea, T. maxima, T. pumila, T. strigosa* (Seshavatharam, 1982b), *Crotalaria intermedia* (Paul & Dutta 1950), *Abrus precatorius* (Venkateswarlu & Seshavatharam 1971). However the ovules are Campylotropous in *Macroptelium atropurpureum* (Swarajyalakshmi et al. 1987) *Wisteria chinensis* (Rembert 1967), *Mucuna prurita* (Ugemuge & Padhye 1986) and *Ulex europaeus* (Chubirko 1987). Hemianatropous ovules have been reported in *Arachis hypogea, A. chacoense, A. glabrata,* and *A. hagenbeckii* (Bharathi & Murthy 1984), while hemianatropous ovules have been reported in *Trifolium* sp. (Kolev & Sedmakova-Luchanska 1972). In *Alysicarpus monilifer* ovule is ana-campylotropous (Seshavatharam 1982a). Antipodals in all the members investigated so far, including *Tephrosia villosa* (present study) are ephemeral. But Makde (1971) reported persistent antipodals in *Indigofera pulchella.*

Johri & Garg (1959) reported that the cells of the endosperm are uninucleate but sometimes a multinucleate condition was seen in the strip of cells adjacent to the haustorium. In our study we have not observed any such multinucleate cells in the endosperm. To confirm we checked both dissected material and the microtome sections. Seshavatharam (1982b) also could not find any such multinucleate endosperm cells in other species of *Tephrosia.*

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Tephrosia villosa (L.) Pers. の胚学的研究を行なった。葯は4室で，葯壁のできかたは双子葉型である。タペタムは分泌状型。花粉四分子は四面体型と十字対生型で，花粉粒は3細胞期に放出される。胚珠は倒生で，2珠皮，厚層珠心となり，四分子は線形，胚嚢のできかたはタデ型である。胚乳形成は遊離核型。Johri & Garg (1959) は *Tephrosia villosa* などにおいて吸器に隣接した胚乳細胞に多核の状態が観察されたと報告したが，本研究ではそのような多核細胞は観察されなかった。

○植物研究雑誌編集会の思い出（木村雄四郎）Yushiro KIMURA: Recollection of early days of the Journal of Japanese Botany

私はこのたび高齢のため，植物研究雑誌の編集員を辞任した。永年に渉り編集員各位のお世話になったことに対して厚く感謝する。この期にあたり，植物研究雑誌が津村研究所で発行されるようになった頃の思い出を記して，参考に供したいと思う。

牧野富太郎先生の植物研究雑誌は大正5年（1916）4月5日に第1巻第1号が創刊されたが，創刊号の巻頭言によれば『本誌ハ時代之ヲ生メリ』として，遠大なる抱負経綸のもとに発表されている。もともと牧野先生の個人雑誌として発行されたもので，出版に要する経費やまとまった読者があったわけではなく，先生は経費の調達に大変苦労されたという。幸いに及川智雄，池永孟両氏の義侠的援助によって第1巻は12号まで，第2巻は6号まで発行されたが，その後久しく休刊されていた（表 1)。

たまたま大正12年（1923）夏に成蹊学園長中村春二氏の援助を受け第3巻1号として